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Research Notes

A Miocene Chimaeroid Fin Spine from Kern County, California

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Chimaeroids are cartilaginous marine fishes with continuously growing tooth plates in the upper and lower jaws, and have long been regarded as an obscure lineage (Didier 1995). They first appear in the fossil record in the Early Jurassic (Ward and Duffin 1989; Stahl 1999) and reached a peak of diversity during the Mesozoic. The group dwindled during the Cenozoic and survive today in only six extant genera assigned to three families (Didier 1995). Fossil chimaeroids are typically preserved as isolated dental plates, dorsal fin spines, and very rarely as complete specimens. In the absence of skeletal elements, chimaeroid species are diagnosed on the characteristics of dental plates. Dorsal fin spines are not diagnostic to species when they are not directly associated with dental or skeletal elements. There is little specific variation in size, length, or ornamentation of fin spines (Case and Herman 1973).

A well-preserved dorsal fin spine of the extinct chimaeroid genus *Edaphodon* Buckland 1838, was recovered from the upper Olcese Sand (late Early Miocene) of California, and is the geochronologically youngest reported occurrence of *Edaphodon* from the fossil record of North America. The fin spine, Natural History Museum of Los Angeles County (LACM) 40211, was collected from the Barker's Ranch area in the southeastern San Joaquin Basin, approximately 13 km northeast of Bakersfield, Kern County, California, and north of the Kern River. The beds in this area contain a gastropod-rich molluscan fauna (the Barker's Ranch Fauna) that serves as a standard of reference for the Miocene provisional mega-invertebrate "Temblor Stage" of Addicott (1972). The locality, LACM locality 6602, is in one of several north-south trending canyons in the NW $^{1}/_{4}$ of Sec. 33, T. 28 S., R. 29 E., Rio Bravo Quadrangle, 7.5 Minute Series (U.S. Geological Survey topographic map). A late Early Miocene age (ca. 16–18 Ma) for this horizon is based on molluscan biochronology (Addicott 1970), biostratigraphic correlation (Savage and Barnes 1972), benthic foraminiferal biostratigraphy (Olson 1990), and strontium isotope data (Olson 1988). The published strontium isotope dates of Olson (1988) yield a mean age of 16.7 Ma near the top of the upper Olcese Sand and are compatible with benthic foraminifera, which suggest an upper Relizian age.

There is some uncertainty surrounding the exact stratigraphic provenance of LACM locality 6602. Clarke and Fitch (1979:492) placed the locality in the "upper part of the Olcese Sand." However, Barnes and Mitchell (1984:17) referred the locality to the "lower part of the Round Mountain Silt, below the Sharktooth

Hill bone bed." Neither provided accurate stratigraphic nor locality data. In the Barker's Ranch area, the upper Olcese Sand is composed of fossiliferous very fine to fine-grained, marine sandstone to sandy siltstone, with interbeds of transported shells, whereas the lowermost Round Mountain Silt is a mottled siltstone (Olson 1990). The specimen was found in a shell bed directly below a calcareously cemented sandstone that is approximately 14 m stratigraphically below a mottled siltstone. The *Edaphodon* specimen described herein is considered to be from sediments of the upper Olcese Sand.

In the 1960's, the late John E. Fitch lead numerous collecting trips to the Barker's Ranch area, and over a period of several years removed and processed nearly 1,800 kg of fossiliferous matrix from the upper Olcese Sand. This material has produced, in addition to LACM 40211, more than 100,000 teleostean otoliths (saccular), which represent as many as 65 species belonging to 30 or more families, several thousand teeth of sharks, skates, and rays, *Cetorhinus* (basking shark) gill rakers, and hundreds of squid statoliths (Clarke and Fitch 1979). Abundant otoliths of sciaenids (drums and croakers), pleuronectids and bothids (right- and left-eyed flatfishes), serranids (basses), atherinids (silversides), mugilids (mullets), clupeids (herrings), and several other families that suggest a nearshore environment, are also present. Otoliths of deepwater forms such as morids (morid cods), melamphaids (bigscale fishes), and myctophids (lanternfishes) are relatively rare.

Systematic Paleontology

Class Chondrichthyes Huxley, 1880
Subclass Subterbranchialia Zangerl, 1979
Superorder Holocephali Bonaparte, 1832
Order Chimaeriformes Obruchev, 1953
Suborder Chimaeroidei Patterson, 1965
Family Callohynchidae Garman, 1901
Subfamily Edaphodontinae Stahl, 1999
Genus *Edaphodon* Buckland, 1838
Edaphodon sp.
Figs. 1–2

Material.—LACM 40211, incomplete distal end of dorsal fin spine, collected by one of the authors (RWH) in 1969 from LACM locality 6602, Barker's Ranch, Kern County, California.

Description.—Partial dorsal fin spine (Fig. 1), measuring 115 mm in preserved length, with undetermined amount of basal portion missing. Laterally compressed, subovate in cross-section, and only slightly curved posteriorly, with faint longitudinal striations on lateral faces. Anterior margin with sharp keel; posterior margin with double row of small, evenly spaced, ventrally curved denticles, separated from each other by a shallow median groove extending for nearly the entire preserved length. In cross-section (Fig. 2), anterior area of spine consists of a thick layer of trabecular tissue with vascular canals; a thin layer of trabecular tissue with vascular canals present on posterior and posterolateral area; a thin layer of lamellar tissue lacking vascular canals present on lateral area of spine; and large subovate pulp cavity present in central region of spine.

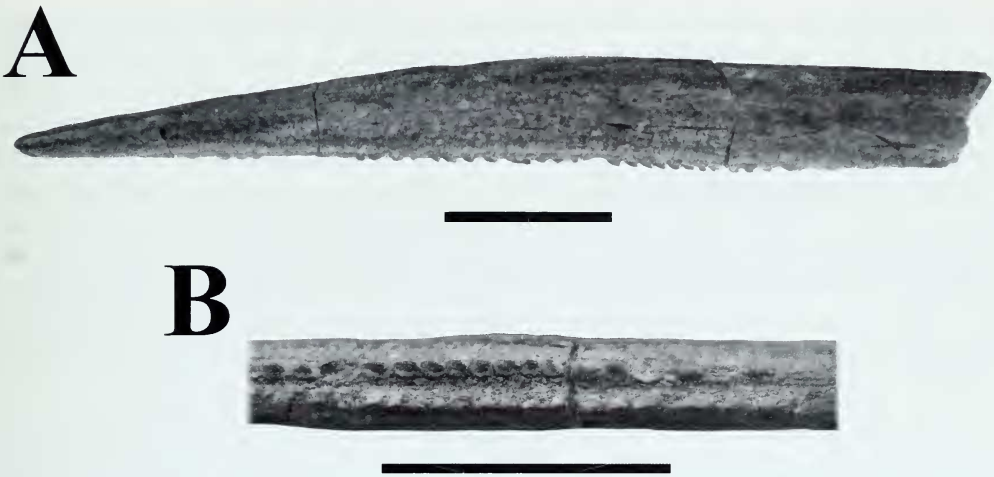

Fig. 1. Incomplete dorsal fin spine of *Edaphodon* sp., LACM 40211. **A.** right lateral view; **B.** posterior view. Scale bars equal 2 cm.

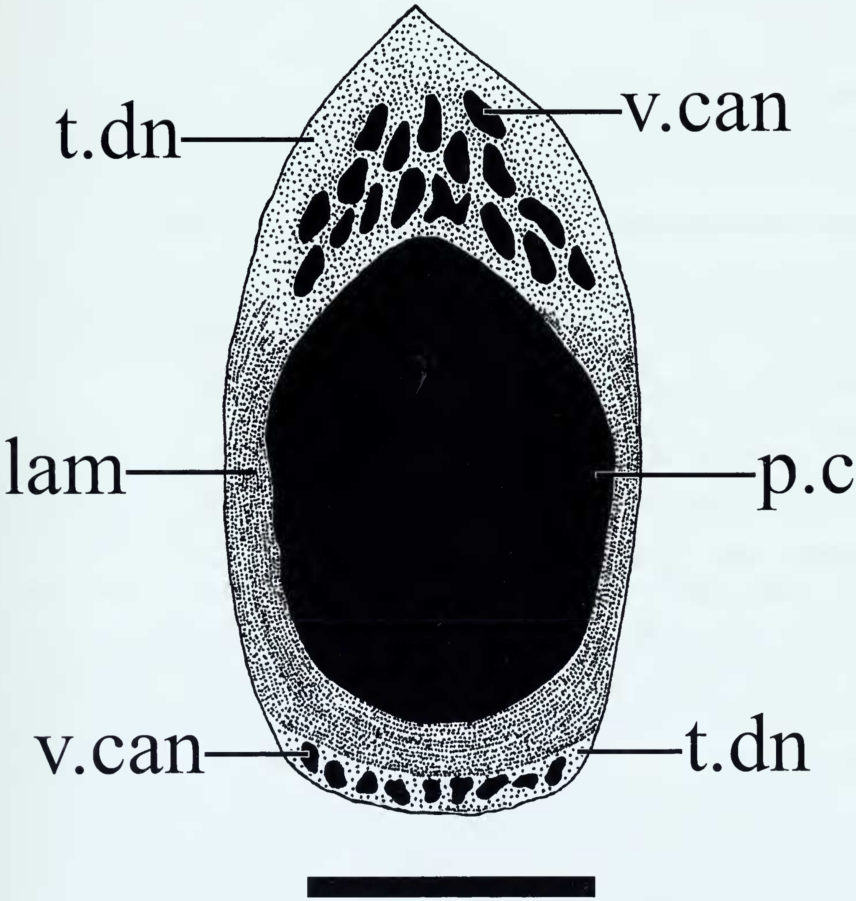

Fig. 2. Cross-section drawing of dorsal fin spine of *Edaphodon* sp., LACM 40211. Scale bar equals 0.5 cm. **Abbreviations**: **lam**, lamellar tissue; **p.c**, pulp cavity; **t.dn**, trabecular tissue; **v.can**, vascular canals.

Comparisons.—LACM 40211 is referable to the extinct chimaeroid genus *Edaphodon.* Assignment of this specimen to a species is unwise based upon such limited material. The dorsal fin spine of *Edaphodon* closely resembles that of the extinct genus *Ischyodus* Egerton 1843, but differs from the latter genus by displaying a weakly compressed subovate fin spine with a large subovate pulp cavity, and an incomplete trabecular tissue layer confined to the anterior and posterior spine edge. The fin spine of *Ischyodus,* in contrast, is strongly compressed laterally, with a narrow rectangular pulp cavity, and the trabecular tissue layer completely surrounds the outer margin of the spine. For description and figure for the fin spine of *Ischyodus* compare also Patterson (1965:113, fig. 4). In recent chimaeroids, the trabecular tissue is restricted to the anterior edge of the spine (Stahl 1999).

Discussion

Edaphodon is known only from tooth plates and fragments of dorsal fin spines, from Early Cretaceous to Pliocene age deposits of Europe, North America, Australia, and Africa (Stahl 1999). In North America, the genus is largely known from Maastrichtian age deposits, and they survived the biotic stresses of Late Cretaceous time to persist into the early part of the Cenozoic. The callorhynchids were thought to have disappeared from the Northern Hemisphere at the end of the Eocene, and persisted in Southern Hemisphere seas throughout the Tertiary (Stahl and Chatterjee 2002). The *Edaphodon* specimen described herein extends the range of the genus in North America to the Early Miocene, and represents the first occurrence of the genus around the eastern north Pacific Rim. This is only the second description of a fossil chimaeroid from California, and reported occurrences of chimaeroids from western North America are very rare. Applegate (1975) described *Ischyodus zinsmeisteri,* a mandibular tooth plate of Paleocene age, from Simi Hills, Ventura County, California. Ward and Grande (1991) regarded features used by Applegate (1975) as ontogenetic, and they considered *I. zinsmeisteri* as a junior synonym of *I. dolloi* Leriche 1902.

Dorsal fin spines generally referred to *Edaphodon* have been typically described as gently arched, slightly compressed, and smooth-walled, except for fine parallel longitudinal striations with a row of denticles along each of its two posterolateral edges, but none along the anterior keel. Duffin and Reynders (1995) reported a complete fin spine referable to *Edaphodon* with a single row of anterior denticles as well as the posterolateral rows. Stahl and Parris (2004) reported fragmentary distal ends of two fin spines associated with a complete dentition of *E. mirificus* Leidy 1856, showing a series of minute enameloid-covered structures on the anterior keel that closely resemble the denticles that Duffin and Reynders (1995) reported. However, on neither of the fin spine fragments was the series of anterior denticles complete. In LACM 40211, denticles are absent from the anterior margin of the preserved half, and it is likely that, as in many chimaeroid fin spines referred to *Edaphodon,* denticles are absent proximally from both the anterior and posterolateral margins. We believe that LACM 40211 is referable to this genus, and further study to determine the significance of the variant patterns of denticle development is required.

Stahl (1999) noted that fossil chimaeroid remains are found in shallow water environments, but it is not certain these fishes actually inhabited such environments. Extant chimaeroids inhabit deepwaters, with some species being known to venture into shallower areas offshore to feed, or even to come nearshore to breed (Bigelow and Schroeder 1953). Obruchev (1967) reported egg cases, but no skeletal remains, of chimaeroids in Mesozoic shallow marine deposits; he believed the egg cases were deposited by species of deepwater chimaeroids that are presently unknown from the fossil record. It is possible that *Edaphodon,* like extant chimaeroids, normally inhabited moderately deepwater environments, but occasionally ventured into the shallows, and this may explain why after extensive sampling only a single chimaeroid specimen has been recovered from the upper Olcese Sand.

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